WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Toxic Conditions in the Lower Anacostia
Focus Categories: TS, WQL
Keywords: ammonia, anoxia, toxics, urban, biomonitoring, molluscs
Duration: March 1, 2000 to February 28, 2001
FY 1999 Federal Funds: $18,764.
FY 1999 Non-Federal Funds: $30,159.
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Congressional District: District of Columbia

Problem and research objectives

The Anacostia River forms a 10 km tidal fresh-water estuary that is wholly within the boundaries of the District of Columbia. It is the major water body of the District. Unfortunately, this estuary is a distinctly unhealthy body of water especially as compared to the Potomac estuary that the Anacostia joins. In addition to a consumption advisory on fish, the bottom life of the Anacostia is highly depauperate (Cummins e.a. 1991). The clams and mussels and submerged aquatic vegetation (SAV) found in the nearby Potomac are missing in the Anacostia (Phelps 1985). Until now most of the problems of the bottom life in the Anacostia have been attributed to contaminants in the sediment (ICPRB 1991, 1992). However, evidence suggests problems may also come from toxic water conditions (anoxia, toxic ammonia) developing in the Anacostia basin in late summer. This needs to be confirmed with continuous-recording probes. Determination of such major sources of toxicity in the Anacostia basin will enable effective decision-making to restore the benthic life. Development of a healthy clam population in the Anacostia could lead to SAV establishment through f~ltration and clearing of the water, and SAV beds in turn would increase the fish populations as in the Potomac (Phelps 1994). This would be a very desirable outcome since the lower Anacostia basin along the DC city waterfront is under consideration as a public access brownfield development.

Statement of results. benefits and/or information.

The development of the lower Anacostia estuary waterfront into a public recreation area will bring into focus the poor quality of the water and the benthic life at that site. This is the first project to carry out continuous monitoring of the benthic water in this area to determine the conditions of anoxia formation and toxic ammonia production in the summer. This will be of use in deciding whether these factors have an overriding influence on the absence of benthic life in this region of the estuary, and put into perspective the relative role of sediment toxics. This information will enable

management decisions for corrections to the estuary to prevent development of such toxic water conditions if found necessary to restore the benthic life of the Anacostia basin.

Nature. scope and objectives of the research.

This study will attempt to monitor the development of toxic water conditions in the lower Anacostia river estuary over three critical months in late summer. It will use multisensor water probes at two sites of interest to continuously record changes in physical and chemical conditions of the water column near the bottom. It will correlate these changes in the water column with mortality in caged clams placed at the sites. The objective of this research will be to identify toxic conditions developing in the water column (anoxia and ammonia toxicity) at the time of year they are most likely to be found, and localize them as much as possible. Effects that are attributable to water column toxicity will require a different form of remediation than those that are attributable to the well-studied sediment contaminants of the Anacostia.

Methods. procedures and facilities.

This proposal will use continuously recording multisensor probes to study the development of toxic conditions in the water column of the lower Anacostia basin in late summer. These probes can be equipped to carry several sondes including temperature, pH, oxygen, turbidity, depth, nitrate and ammonia. The probe is suspended in the water column and can be set to take readings at half-hour intervals. Once a week the probe will be recovered, the information downloaded, and the sondes cleaned, and recalibrated. The information on temperature and depth will show tidal excursions, the oxygen probe will indicate development of anoxic conditions, the turbidity probe will indicate rain events and dilution of the water column, and the nitrate, ammonia, pH and temperature probes will indicate conditions for the development of ammonia toxicity.

These multisensor probes are individually quite expensive (around $15,000) but can be rented for $1900 a month. With the money available in this proposal we could rent two multisensor probes for three critical late-summer months, July, August and September. It is proposed to locate them at the Navy Yard and at the Pump House, two sites that bracket the area under consideration for development of the public access brownfield recreational area and where they can be kept under observation. Two sites will enable some location of where toxic conditions develop.

Along with the probes, cages of mature and young Asiatic clams on control Potomac sediment would be placed at the sites. The cages will be pulled up and the clams observed weekly for mortality while the probes are being cleaned and downloaded. The clam mortality would be a clear indicator of the development of water column toxicity at the sites. This project will help to distinguish between the effects of sediment toxicity and water column toxicity on Anacostia benthic life. This project can also be used as an example in the educational outreach projects of the Earth Conservation Corps to teach modern ecological research methods.

Related Research:

The absence of benthic life in the lower Anacostia basin near the city aside from small worms and midge larvae has been attributed to sediment toxicity (ICPRB 1991, 1992). However, sediment bioassays found toxicity only at some times and not after a rainstorm with deposition of new sediment material (Phelps 1993). A recent study of toxic chemicals in Anacostia sediments found highest concentrations and possible biological effects levels in the upper estuary but not at the DC waterfront (Navy Yard)

(Phelps 2000). This study also found that adult clams did not accumulate most toxic chemicals from Anacostia sediments although clams did accumulate toxics from the water column.

We did an earlier study of toxicity at the waterfront area by placing cages of Anacostia (Navy Yard) sediment in the Potomac and cages of Potomac sediment at the Navy Yard (Phelps 1991). Mature Asiatic clams collected from the Potomac were added to both sets of cages for four spring-summer months. Adult clams in both cages survived. However, young clams growing in cages in the Anacostia had 100% mortality. Young clam survival was much better on Anacostia sediment placed in the Potomac. The Anacostia and Potomac sediments and conditions allowed survival and growth but there was a sudden toxic event occurring in Anacostia water in late summer that killed the young clams.

One highly toxic compound found in fresh (but not salt) water is un-ionized ammonia (Ankley e.a 1990). The normal degradation of organic compounds forms nontoxic ammonia which changes to- un-ionized (toxic) ammonia under conditions of increased temperature and pH. Asiatic clams are very sensitive to ammonia (Dougherty and Cherry, 1988). A toxicity experiment conducted with larvae of the Asiatic clam compared sediment from the Navy Yard and control sediment from the Potomac (Phelps and Clark 1988; Phelps 1994). When Navy Yard sediment pH was raised to 9 and neutralized before bioassay the larval mortality increased from 7 to 98% but this did not occur in control sediment. This standard sediment modification procedure causes the formation o~onized (toxic) ammonia from nontoxic ammonia. These results suggested Navy Yard sediment contained suff~cient ammonia from organic degradation to cause water column toxicity under the right conditions of pH and temperature.

The hydrology of the lower basin of the Anacostia retains water up to two weeks which could lead to ammonia buildup. We rented a multisensor probe for one month and found lower Anacostia basin water in September reached a pH of 8.6 at a temperature of 24 deg. C at the Pump House site (Phelps, unpub.). These conditions would convert about 30% of natural ammonia to the toxic un-ionized form. High pH water was found entering the lower Anacostia nearby from a cement plant (pers. obs.). In addition, sediment bioassay study of Kenilworth Marsh sediments found toxicity only under conditions of ammonia formation (Phelps 1995).

Another possible source of toxicity for benthics in lower Anacostia estuary basin water is anoxia. Anoxia has been reported by the DC Dept. Of Natural Resources to occur at the bottom of the lower estuary in late summer (Freudberg e.a. 1989). Though clams tend to be less sensitive to anoxia, both anoxia and toxic ammonia in the water cause high mortality and could be responsible for major effects on the benthic life of the lower Anacostia. These water column effects would be independent of the effects of sediment toxics and could be more serious.

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